

Development of an IoT-Based Smart Street Lighting and Solar Generation Monitoring System for Energy Conservation

Arvind Verma, Hari Om, Harshit Gupta, Mayank Mudgal, Dr. Rakesh Kumar Joon, Mr. Satish
Ganga Institute of Technology & Management, Kablana

Abstract: *Municipal street lighting represents a critical public infrastructure service that accounts for roughly 18% to 38% of total global energy expenditures within public spaces. Conventional High-Intensity Discharge (HID) luminaires operate continuously at peak capacity irrespective of real-time pedestrian or vehicular traffic, resulting in significant electrical waste, inflated utility costs, and heightened carbon footprints. This paper presents the architecture, implementation, and empirical verification of an affordable, automated, and Internet of Things (IoT)-enabled Energy Conservation System. The system replaces obsolete HID fixtures with directional, dimmable Light Emitting Diodes (LEDs) controlled by an ESP8266 NodeMCU microcontroller framework. Utilizing an array of Light Dependent Resistors (LDRs) and active Infrared (IR) sensors, the localized firmware alters luminaire illumination levels dynamic to environmental lighting changes and live object presence. Concurrently, the system acts as a micro-generation hub, incorporating a photovoltaic solar panel integrated with a telemetry network that reports real-time voltage generation data to the cloud using HTTP web protocols. Experimental outcomes demonstrate substantial power consumption savings, simplified maintenance telemetry, and reduced light pollution, paving a realistic pathway toward sustainable smart-city frameworks.*

Keywords: Energy Conservation, Smart Street Light, Internet of Things (IoT), ESP8266 NodeMCU, Infrared Sensor, Photo-Conductivity, Cloud Data Analytics

